PLATE THICKNESS MEASUREMENT METHOD AND DEVICE FOR PLATE TYPE TRANSPARENT MATERIAL

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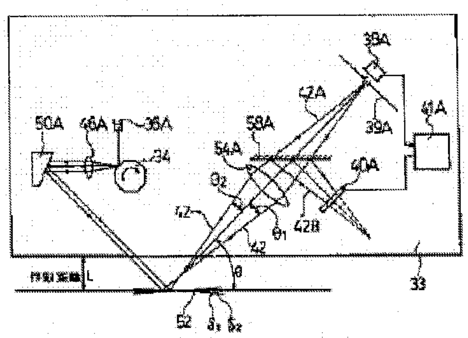
Abstract of **JP8014840**

PURPOSE:To accurately calculate the thickness of a plate type transparent material at all times by correcting the thickness on the basis of the inclination angle or curvature of the material obtainable from the reflection angle of reflected light. CONSTITUTION:When a laser beam 42 comes to be incident on a plate thickness detection sensor 38A, a position detection sensor 40A detects the optical path position of another laser beam 42B incident thereon. Then, the reflection angle dislocation theta1 of a laser beam 42 is calculated on the basis of a working distance L and the optical path position detected with the sensor 40A. Also, the reflection angle dislocation theta2 of the beam 42A is, if any, similarly calculated. At the same time, the reflection angle dislocations theta1' and theta2' of the beam 42 due to the similar inclination of plate glass 52 are calculated by use of the plate thickness detection sensor and position detection sensor of another plate thickness measurement means at the left side. In addition, an operation means 41A calculates the inclination angle of the glass 52 on the basis of the reflection angle dislocations theta1 and theta1', and theta2 and theta2'. Furthermore, the operation means 41A makes a correction for a measurement error, using a plate thickness measurement error chart for the preliminarily measured inclination of the glass 52.



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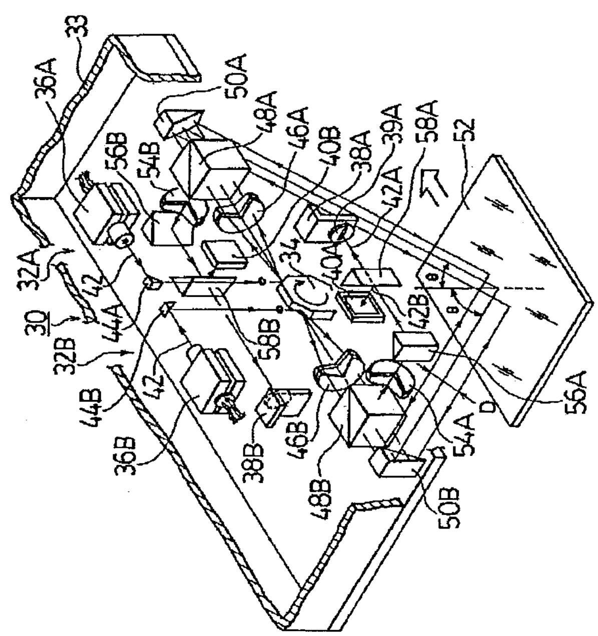
(54)【発明の名称】 板状透明体の板厚測定方法及び装置

(57)【要約】

【構成】 板厚検出センサ３８Ａは、板ガラス５２の表面及び裏面で反射されたそれぞれの反射光４２の時間差に基づいて板ガラス５２の板厚を求める。同時に、位置検出センサ４０Ａは反射光４２の光路位置を検出し、検出した光路位置に基づいて反射光４２の反射角を求める。演算手段４１Ａは反射光の反射角に基づいて板ガラス５２の傾斜角や曲率を求め、求めた傾斜角や曲率に基づいて測定板厚を補正する。

【効果】 板ガラスが振動で傾斜した場合や、板ガラスにうねりが形成されている場合でも板ガラスの板厚を正確に算出する。



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【特許請求の範囲】

【請求項1】　照射光を板状透明体の表面に斜めに入射するように照射し、この照射光を平行走査し、
前記照射光の前記板状透明体の表面で反射した反射光と前記照射光の前記板状透明体の裏面で反射した反射光との時間差を測定し、
該測定された時間差に基づいて前記板状透明体の板厚を求め、
前記板状透明体の表面及び裏面で反射された前記反射光の反射角を求め、
前記反射光の反射角に基づいて前記板状透明体の傾斜角を求め、
前記前記板状透明体の傾斜角に基づいて、前記求められた板厚を補正することを特徴とする板状透明体の板厚測定方法。

【請求項2】　照射光を板状透明体の表面に斜めに入射するように照射し、この照射光を平行走査し、
前記照射光の前記板状透明体の表面で反射した反射光と前記照射光の前記板状透明体の裏面で反射した反射光との時間差を測定し、
該測定された時間差に基づいて前記板状透明体の板厚を求め、
前記板状透明体の表面及び裏面で反射された前記反射光の反射角を求め、
前記反射光の反射角に基づいて前記板状透明体の曲率を求め、
前記前記板状透明体の曲率に基づいて、前記求められた板厚を補正することを特徴とする板状透明体の板厚測定方法。

【請求項3】　照射光を板状透明体の表面に斜めに入射するように照射する照射手段と、
前記照射光の前記板状透明体の表面で反射した反射光と前記照射光の前記板状透明体の裏面で反射した反射光との時間差を測定し、該測定された時間差に基づいて前記板状透明体の板厚を求める板厚検出手段と、
前記板状透明体の表面及び裏面で反射された前記反射光の反射角を検出する反射角検出手段と、
前記反射光の反射角に基づいて前記板状透明体の傾斜角を求め、該板状透明体の傾斜角に基づいて前記求められた板厚を補正する演算手段と、
を備えたことを特徴とする板状透明体の板厚測定装置。

【請求項4】　照射光を板状透明体の表面に斜めに入射するように照射する照射手段と、
前記照射光の前記板状透明体の表面で反射した反射光と前記照射光の前記板状透明体の裏面で反射した反射光との時間差を測定し、該測定された時間差に基づいて前記板状透明体の板厚を求める板厚検出手段と、
前記板状透明体の表面及び裏面で反射された前記反射光の反射角を検出する反射角検出手段と、
前記反射光の反射角に基づいて前記板状透明体の曲率を求め、該板状透明体の曲率に基づいて前記求められた板厚を補正する演算手段と、
を備えたことを特徴とする板状透明体の板厚測定装置。

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【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、板ガラス等の板状透明体の板厚を算出する板状透明体の板厚測定方法及び装置に関する。

【0002】

【従来の技術】板ガラス等の板状透明体の板厚を測定する方法として図6に示す方法が知られている。すなわち、光源10から投光されたレーザ光12を回転中のポリゴンミラー14に照射し、ポリゴンミラー14で反射された光ビーム12を集光レンズ16を介して板ガラス18の表面に照射する。レーザ光12は板ガラス18にθの角度で照射し、ポリゴンミラー14の回転により板ガラス18の搬送方向に走査される。

【0003】板ガラス18の表面に照射した照射光は、板ガラス18の表面及び板ガラス18の裏面で反射される。そして、板ガラス18の表面の反射光及び板ガラス18の裏面の反射光は、それぞれ集光レンズ20に導かれる。集光レンズ20に導かれたそれぞれの反射光はスリット22を介してフォトダイオード24に入射する。この場合、ポリゴンミラー14の回転速度をvとしてレーザ光12の走査速度を一定に設定すると、板ガラス18の表面で反射されたレーザ光と板ガラス18の裏面で反射されたレーザ光とは走査幅Dに比例した時間間隔で検出される。

【0004】従って、板ガラス18の表面で反射されたレーザ光と板ガラス18の裏面で反射されたレーザ光とがフォトダイオード24に入射したときの時間差を測定して、測定した時間差に基づいて板ガラス18の板厚tが求められる。

【0005】

【発明が解決しようとする課題】この場合、板ガラス18の板厚tは次式（1）で算出される。

$$t=\frac{\sqrt{(n^2-\sin^2\theta)}}{\sin 2\theta}\cdot\frac{D}{v}$$

但し、v：照射光の平行走査速度
n：板ガラス18の屈折率

（1）式に示すように板ガラス18の板厚tはレーザ光18の入射角θ及びレーザ光の走査幅Dの関数で現わされ、入射角θ及び走査幅Dはそれぞれ板ガラス18が傾斜すると変化する。

【0006】ところで、図6上で板ガラス18は矢印方向に搬送され、板ガラス18の搬送時に振動が生じると板ガラス18が傾斜する。このように、傾斜状の板ガラス18の板厚を測定した場合、（1）式に示すように板ガラス18の板厚を正確に求めることができないという

問題がある。また、板ガラス１８にうねりが形成されている場合、うねりの部分が曲面状に形成されているので傾斜状の板ガラス１８と同様に板ガラス１８の板厚を正確に求めることができないという問題がある。

【０００７】本発明は、このような事情に鑑みてなされたもので、板状透明体が振動で傾斜した場合や、板状透明体にうねりが形成されている場合でも板状透明体の板厚を正確に算出することができる板状透明体の板厚測定方法及び装置を提供することを目的としている。

【０００８】

【課題を解決する為の手段】本発明は、照射光を板状透明体の表面に斜めに入射するように照射し、この照射光を平行走査し、前記照射光の前記板状透明体の表面で反射した反射光と前記照射光の前記板状透明体の裏面で反射した反射光との時間差を測定し、該測定された時間差に基づいて前記板状透明体の板厚を求め、前記板状透明体の表面及び裏面で反射された前記反射光の反射角を求め、前記反射光の反射角に基づいて前記板状透明体の傾斜角又は曲率を求め、前記前記板状透明体の傾斜角又は曲率に基づいて、前記求められた板厚を補正することを特徴とする板状透明体の板厚測定方法、及びその装置である。

【０００９】

【作用】本発明によれば、照射手段から照射された照射光を板状透明体の表面に斜めに照射して板状透明体の表面及び表面で反射させる。板厚検出手段は板状透明体の表面及び表面で反射されたそれぞれの照射光の時間差を測定し、測定された時間差に基づいて板状透明体の板厚を求める。同時に、反射角検出手段は反射光の光路位置を検出して、検出した光路位置に基づいて反射光の反射角を求める。演算手段は反射角検出手段で検出された反射角に基づいて板状透明体の傾斜角又は曲率を求め、求められた板状透明体の板厚を補正する。

【００１０】

【実施例】以下添付図面に従って本発明に係るに板状透明体の板厚測定方法及び装置について細説する。図１は本発明に係るに板状透明体の板厚測定装置の斜視図であり、図２はその動作説明図である。板状透明体の板厚測定装置３０は左右対称となる右側の板厚測定手段３２Ａ及び左側の板厚測定手段３２Ｂを備え、それぞれの板厚測定手段３２Ａ、３２Ｂはセンサボックス３３内に収納されている。そして、板厚測定手段３２Ａ、３２Ｂはそれぞれポリゴンミラー３４を共用している。

【００１１】ポリゴンミラー３４はセンサボックス３３の略中央に回動自在に支持され、矢印方向（時計回り方向）に一定の回転速度で回転する。右側の板厚測定手段３２Ａはレーザ光源（照射手段）３６Ａ、板厚検出センサ（板厚検出手段）３８Ａ、位置検出センサ（反射角検出手段）４０Ａ及び演算手段４１Ａ（図２参照）等を備え、左側の板厚測定手段３２Ｂはレーザ光源３６Ｂ、板厚検出センサ３８Ｂ、位置検出センサ４０Ｂ及び演算手段（図示せず）等を備えている。尚、右側の板厚測定手段３２Ａと左側の板厚測定手段３２Ｂは左右対称に構成されているので、以下、右側の板厚測定手段３２Ａについて説明して左側の板厚測定手段３２Ｂについては説明を省略する。

【００１２】右側の板厚測定手段３２Ａのレーザ光源３６Ａはポリゴンミラー３４の右上方に設けられ、レーザ光源３６Ａはスポット状のレーザ光（照射光）４２を平行光として前方（左方向）に投光する。レーザ光源３６Ａの前方（左側）にはプリズム４４Ａが設けられ、プリズム４４Ａはレーザ光源３６Ａから投光されたレーザ光４２を略９０°の角度で下向きに反射してポリゴンミラー３４の右側周面に導く。ポリゴンミラー３４の右方向には集光レンズ４６Ａが配置され、集光レンズ４６Ａの右方向にはハーフミラー４８Ａが配置されている。また、ハーフミラー４８Ａの右方向にはプリズム５０Ａが配置されている。

【００１３】そして、集光レンズ４６Ａはポリゴンミラー３４で走査されたレーザ光４２をハーフミラー４８Ａに平行光として導き、ハーフミラー４８Ａは集光レンズ４６Ａから伝達されたレーザ光４２の１／２を透過してプリズム５０Ａに導く。プリズム５０Ａはハーフミラー４８Ａから伝達されたレーザ光４２を下方斜め方向に反射し、反射したレーザ光４２を板ガラス５２に入射角θで入射させる。これにより、レーザ光４２は板ガラス５２の表面と裏面とで反射される。板ガラス５２はポリゴンミラー３４の下方に位置して、矢印方向に搬送されている。

【００１４】板ガラス５２の左側上方にはプリズム５０Ｂ及びハーフミラー４８Ｂが配置され、プリズム５０Ｂ及びハーフミラー４８Ｂは、ポリゴンミラー３４を中心にしてプリズム５０Ａ及びハーフミラー４８Ａの対称位置に位置している。プリズム５０Ｂには板ガラス５２の表面と裏面とで反射されたレーザ光４２が入射し、プリズム５０Ｂは入射したレーザ光４２を水平方向に反射してハーフミラー４８Ｂまで導く。ハーフミラー４８Ｂはレーザ光４２の１／２を横方向に略９０°反射させる。

【００１５】ハーフミラー４８Ｂの横方向には集光レンズ５４Ａが配置され、集光レンズ５４Ａの横方向にはプリズム５６Ａが配置されている。そして、集光レンズ５４Ａはハーフミラー４８Ｂで反射されたレーザ光４２をプリズム５６Ａに導き、プリズム５６Ａは集光レンズ５４Ａから伝達されたレーザ光４２を水平方向に９０°反射する。プリズム５６Ａで反射されたレーザ光４２の進行方向にはハーフミラー５８Ａが配置されている。ハーフミラー５８Ａは入射光の１／２を透過して右方向に導き、残りのレーザ光４２Ｂを水平方向に９０°反射して横方向に導く。

【００１６】ハーフミラー５８Ａの右方向には板厚検出

センサ３８Ａが設けられている。板厚検出センサ３８Ａは１例としてフォトダイオードが使用され、板厚検出センサ３８Ａの前面にはスリット３９Ａが設けられている。従って、板厚検出センサ３８Ａにはハーフミラー５８Ａを透過したレーザ光４２Ａがスリット３９Ａを介して入射する。この場合、ポリゴンミラー３４の回転速度を一定に設定してレーザ光４２の走査速度ｖを一定に設定すると、板ガラス５２の表面で反射されたレーザ光と板ガラス５２の裏面で反射されたレーザ光とは走査幅Ｄに比例した時間間隔で検出される。

【００１７】従って、板ガラス５２の表面で反射されたレーザ光と板ガラス５２の裏面で反射されたレーザ光とがスリット３９Ａを介して板厚検出センサ３８Ａに到達する時間差を計測して板ガラス５２の仮の板厚を求める。板厚検出センサ３８Ａで求められた仮の板厚は後述する演算手段４１Ａに入力される。また、ハーフミラー５８Ａの横方向には位置検出センサ４０Ａが配置されている。位置検出センサ４０Ａは１例として二次元ＰＳＤ（Position Sensing Device.日本語で位置検出センサ）が使用され、位置検出センサ４０Ａにはハーフミラー５８Ａで反射されたレーザ光４２Ｂが入射する。以下、図２において位置検出センサ４０Ａについて説明する。板ガラス５２が傾斜していない場合レーザ光４２は反射角θで反射される（図１参照）。一方、図２に示すように、ガラス５２がδ_1傾斜した場合、レーザ光４２の反射角は反射角θからθ_1下方にズレる。また、ガラス５２がδ_2傾斜した場合、レーザ光４２の反射角は反射角θからθ_2上方にズレる。

【００１８】ここで、反射角が反射角θからθ_1下方にズレた場合について説明する。レーザ光４２Ａが板厚検出センサ３８Ａに入射した時、位置検出センサ４０Ａは位置検出センサ４０Ａに入射したレーザ光４２Ｂの光路位置を検出する。そして、作動距離Ｌ（センサボックス３３の底面と板ガラス５２の搬送面との間の距離）と位置検出センサ４０Ａが検出した光路位置に基づいてレーザ光４２の反射角ズレθ_1を算出する。また、レーザ光４２Ａの反射角が反射角θからθ_2ずれた場合も同様に算出される。

【００１９】同時に、図１に示す左側の板厚測定手段３２Ｂの板厚検出センサ３８Ｂ及び位置検出センサ４０Ｂを使用して板ガラス５２がδ_1傾斜した場合のレーザ光４２の反射角ズレθ_1'（図３参照）を算出する。そして、演算手段４１Ａは、レーザ光４２の反射角ズレθ_1、θ_1'から板ガラス５２のδ_1傾斜角を算出する。また、板ガラス５２のδ_2傾斜角も同様に算出される。そして、予め測定していた板ガラス５２の傾きによる板厚測定誤差グラフ（図４参照）から誤差分を補正する。

【００２０】図３に示すように、板ガラス５２に左右方向からそれぞれ斜めにレーザ光４２を照射させることにより（ダブルビーム方式）、板ガラス５２が傾斜したときの傾斜角を求めることができる。一方、板ガラス５２に左右方向のいずれか一方のみから斜めにレーザ光４２を照射させた場合は（シングルビーム方式）、板ガラス５２が傾斜状態であるのか、上下方向に垂直移動した状態であるのかの判別を行うことができない。

【００２１】次に、図４において板厚測定誤差グラフを説明する。板厚測定誤差グラフはレーザ光４２の板ガラス５２に対する入射角度と板厚補正値との関係を示し、縦軸が板厚補正値、横軸が板ガラス５２の傾斜角度を示している。例えば、板厚測定誤差グラフにおいて、左上がり勾配のグラフG_1を右側の板厚測定手段３２Ａから求めたグラフとし、左上がり勾配のグラフG_2を右側の板厚測定手段３２Ａから求めたグラフとすると、グラフG_1、G_2は０～±５０（分）の範囲で板ガラス５２を傾斜させたときの板ガラス５２の板厚の補正値を求めたものである。

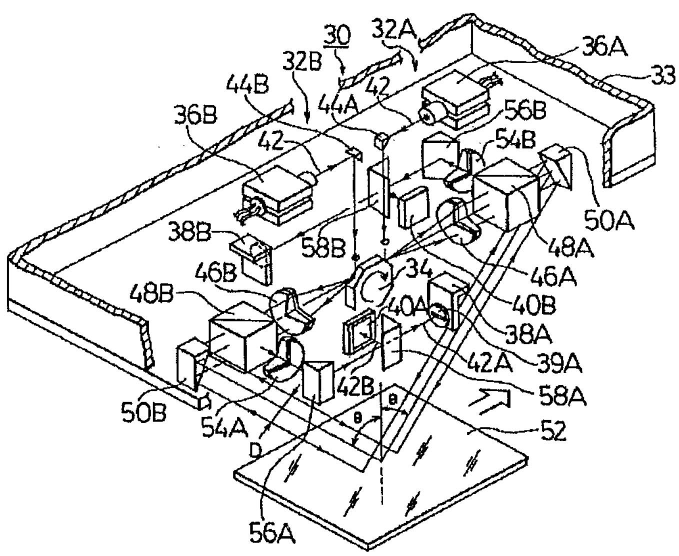
【００２２】この板厚測定誤差グラフは板ガラス５２の板厚測定の前に予め作成される。従って、上述した方法で板ガラス５２の傾斜角δ_1、δ_2を求めると、板厚測定誤差グラフからグラフG_1、G_2の板厚補正値を求めることができる。例えば、板ガラス５２の傾斜角δ_1が＋３０分と求められた場合、グラフG_1、G_2からそれぞれの板厚補正値S_1、S_2を求め、板厚補正値S_1、S_2に基づいて板ガラス５２の傾斜角δ_1時の板厚誤差分を補正する。

【００２３】前記実施例では板ガラス５２が傾斜したときの板厚誤差分を補正する場合について説明したが、これに限らず、本発明に係る板状透明体の板厚測定方法及び装置をうねりが形成された板ガラスの板厚測定値の板厚誤差分の補正に使用することができる。以下、図５においてうねりが形成された板ガラス６２の板厚を補正する場合について説明する。図５はレーザ光源３６Ａ及びレーザ光源３６Ｂから投光されたレーザ光４２がそれぞれプリズム５０Ａ及びプリズム５０Ｂ（図１参照）を介して板ガラス６２で反射された状態を示した平面図である。

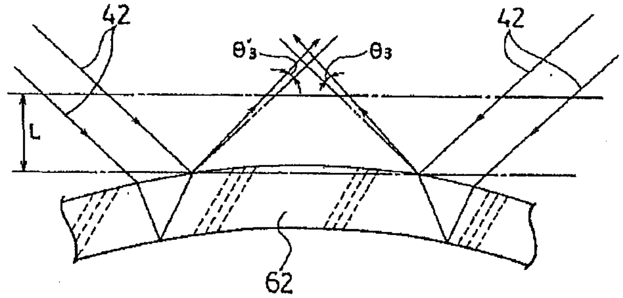
【００２４】この場合、板厚検出センサ３８Ａは前記実施例と同様にうねりによる曲面状板ガラス６２の仮の板厚を求める。すなわち、板厚検出センサ３８Ａは、曲面状板ガラス６２の表面で反射されたレーザ光とその裏面で反射されたレーザ光とがスリット３９Ａを介して板厚検出センサ３８Ａに到達する時間差を計測して曲面状板ガラス６２の板厚を求める。さらに、位置検出センサ４０Ｂは前記実施例と同様にレーザ光４２、４２のそれぞれの反射角ズレθ_3、θ_3'を求め、演算手段４１Ａはレーザ光４２の反射角ズレθ_3、θ_3'から曲面状板ガラス６２の曲率を求める。そして、演算手段４１Ａは、曲面状板ガラス６２の曲率に対応する補正値を求めて曲面状板ガラス６２の仮の板厚の測定誤差を補正する。

【００２５】
【発明の効果】以上説明したように本発明に係る板状透明体の板厚測定方法及び装置によれば、板厚検出手段は板状透明体の表面及び表面で反射されたそれぞれの照射光の時間差を測定し、測定された時間差に基づいて板状透明体の板厚を求める。同時に、反射角検出手段は反射光の光路位置を検出して、検出した光路位置に基づいて反射光の反射角を求める。演算手段は反射角検出手段で検出された反射角に基づいて板状透明体の傾斜角又は曲率を求め、求められた板状透明体の板厚を補正する。
【００２６】従って、板状透明体が振動で傾斜した場合や、板状透明体にうねりが形成されている場合でも板状透明体の板厚を正確に算出することができる。
【図面の簡単な説明】
【図１】本発明に係る板状透明体の板厚測定装置の全体を示す斜視図
【図２】本発明に係る板状透明体の板厚測定装置の動作を説明する説明図
【図３】板ガラスが傾斜した場合のレーザ光の反射状態を説明した説明図
【図４】レーザ光の入射角度と板厚補正値との関係を示した板厚測定誤差グラフ
【図５】曲面状板ガラスにおけるレーザ光の反射状態を説明した説明図
【図６】従来の板状透明体の板厚測定装置を示す正面図
【符号の説明】
３０…板状透明体の板厚測定装置
４２…レーザ光（照射光）
５２、６２…板ガラス（板状透明体）
３６Ａ、３６Ｂ…レーザ光源（照射手段）
３８Ａ、３８Ｂ…板厚検出センサ（板厚検出手段）
４０Ａ、４０Ｂ…位置検出センサ（反射角検出手段）
４１Ａ…演算手段

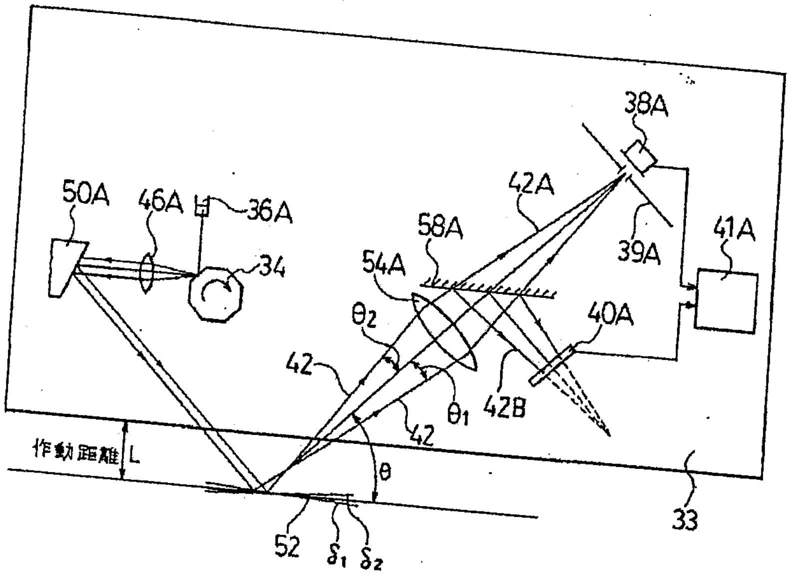
【図１】



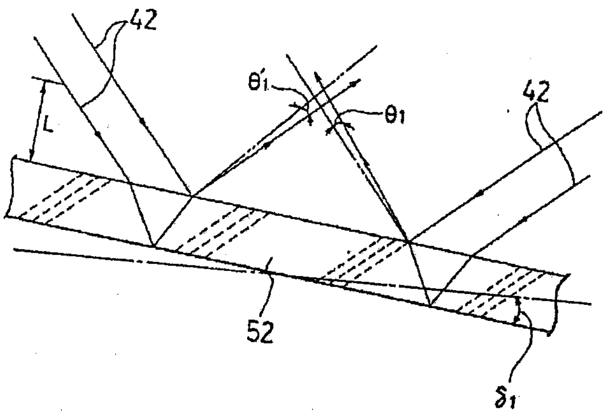
【図５】



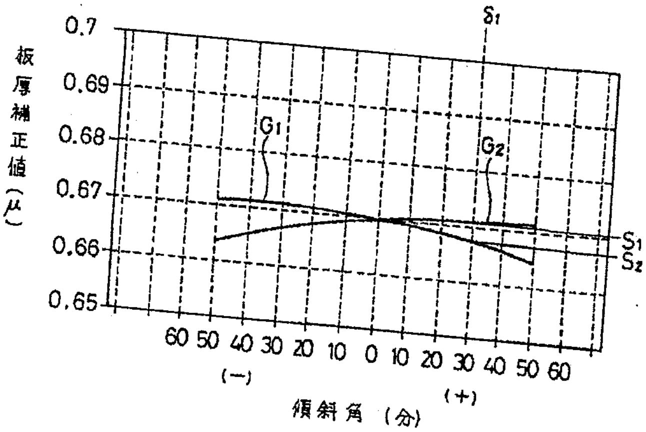
【図2】


38A
42A
50A
46A
36A
34
58A
54A
39A
41A
θ2
40A
42
θ1
42B
42
作動距離
L
θ
52
δ1
δ2
33

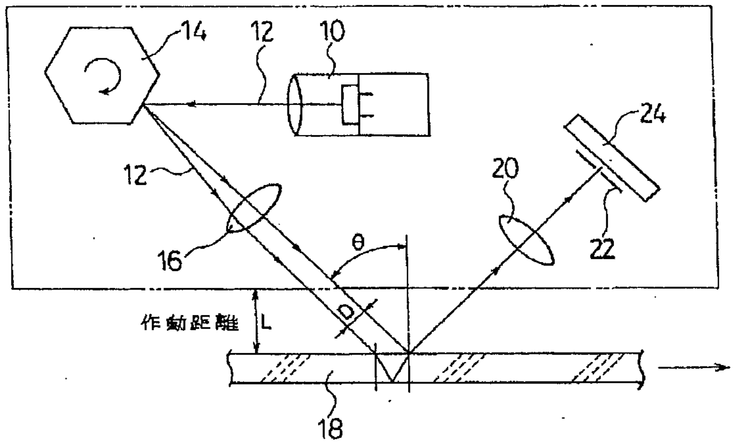
【図3】


42
θ'1
θ1
42
L
52
δ1

【図4】


板厚補正値(μ)
0.7
0.69
0.68
0.67
0.66
0.65
δ1
G1
G2
S1
S2
60 50 40 30 20 10 0 10 20 30 40 50 60
(−)
(+)
傾斜角（分）

【図6】



PATENT ABSTRACTS OF JAPAN

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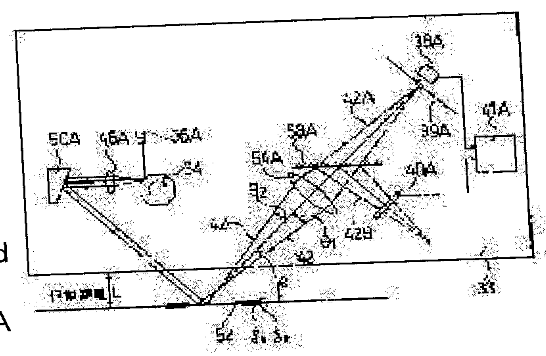
(54) PLATE THICKNESS MEASUREMENT METHOD AND DEVICE FOR PLATE TYPE TRANSPARENT MATERIAL

(57)Abstract:
PURPOSE: To accurately calculate the thickness of a plate type transparent material at all times by correcting the thickness on the basis of the inclination angle or curvature of the material obtainable from the reflection angle of reflected light.
CONSTITUTION: When a laser beam 42 comes to be incident on a plate thickness detection sensor 38A, a position detection sensor 40A detects the optical path position of another laser beam 42B incident thereon. Then, the reflection angle dislocation θ1 of a laser beam 42 is calculated on the basis of a working distance L and the optical path position detected with the sensor 40A. Also, the reflection angle dislocation θ2 of the beam 42A is, if any, similarly calculated. At the same time, the reflection angle dislocations θ1' and θ2' of the beam 42 due to the similar inclination of plate glass 52 are calculated by use of the plate thickness detection sensor and position detection sensor of another plate thickness measurement means at the left side. In addition, an operation means 41A calculates the inclination angle of the glass 52 on the basis of the reflection angle dislocations θ1 and θ1', and θ2 and θ2'. Furthermore, the operation means 41A makes a correction for a measurement error, using a plate thickness measurement error chart for the preliminarily measured inclination of the glass 52.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the board thickness measuring method and equipment of the tabular transparent body which compute the board thickness of the tabular transparent bodies, such as sheet glass.
[0002]
[Description of the Prior Art] The approach shown in drawing 6 as an approach of measuring the board thickness of the tabular transparent bodies, such as sheet glass, is learned. That is, the polygon mirror 14 while rotating the laser beam 12 floodlighted from the light source 10 is irradiated, and the light beam 12 reflected by the polygon mirror 14 is irradiated on the front face of sheet glass 18 through a condenser lens 16. A laser beam 12 irradiates sheet glass 18 at an angle of theta, and is scanned in the conveyance direction of sheet glass 18 by rotation of the polygon mirror 14.
[0003] The exposure light which irradiated the front face of sheet glass 18 is reflected with the front face of sheet glass 18, and the rear face of sheet glass 18. And the reflected light of the front face of sheet glass 18 and the reflected light of the rear face of sheet glass 18 are led to a condenser lens 20, respectively. Incidence of each reflected light led to the condenser lens 20 is carried out to a photodiode 24 through a slit 22. In this case, if the scan speed of a laser beam 12 is set up uniformly, using rotational speed of the polygon mirror 14 as v, the laser beam reflected on the front face of sheet glass 18 and the laser beam reflected with the rear face of sheet glass 18 will be detected with the time interval proportional to swath width D.
[0004] Therefore, time difference when the laser beam reflected on the front face of sheet glass 18 and the laser beam reflected with the rear face of sheet glass 18 carry out incidence to a photodiode 24 is measured, and the board thickness t of sheet glass 18 is called for based on the measured time difference.
[0005]
[Problem(s) to be Solved by the Invention] In this case, the board thickness t of sheet glass 18 is computed by the degree type (1).

$$t = \frac{\sqrt{(n^2 - \sin^2\theta)}}{\sin 2\theta} \cdot \frac{D}{v}$$

However, the parallel-scanning rate n of v:exposure light: As shown in the refractive-index (1) type of sheet glass 18, the board thickness t of sheet glass 18 is expressed with the function of the incident angle theta of a laser beam 18, and the swath width D of a laser beam, and the incident angle theta and swath width D will change, if sheet glass 18 inclines, respectively.
[0006] By the way, sheet glass 18 is conveyed in the direction of an arrow head on drawing 6 , and if vibration arises at the time of conveyance of sheet glass 18, sheet glass 18 inclines. Thus, when the board thickness of the sheet glass 18 of the letter of an inclination is measured, there is a problem that it cannot ask for the board thickness of sheet glass 18 correctly as shown in (1) type. Moreover, when the wave is formed in sheet glass 18, since the part of a wave is formed in the shape of a curved surface, there is a problem that it cannot ask for the board thickness of sheet glass 18

correctly like the sheet glass 18 of the letter of an inclination.
[0007] This invention was made in view of such a situation, and when the tabular transparent body inclined by vibration, or even when the wave is formed in the tabular transparent body, it aims at offering the board thickness measuring method and equipment of the tabular transparent body which can compute the board thickness of the tabular transparent body correctly.
[0008]
[Means for Solving the Problem] This invention is irradiated so that incidence of the exposure light may be aslant carried out on the front face of the tabular transparent body. Carry out parallel scanning of this exposure light, and the time difference of the reflected light reflected on the front face of said tabular transparent body of said exposure light and the reflected light reflected with the rear face of said tabular transparent body of said exposure light is measured. Ask for the board thickness of said tabular transparent body based on the measured this time difference, and the angle of reflection of said reflected light reflected with the front face and rear face of said tabular transparent body is searched for. They are the board thickness measuring method of the tabular transparent body characterized by asking for the tilt angle or curvature of said tabular transparent body based on the angle of reflection of said reflected light, and amending said called-for board thickness based on the tilt angle or curvature of said said tabular transparent body, and its equipment.

[0009]
[Function] According to this invention, the front face of the tabular transparent body is irradiated aslant, and the exposure light irradiated from the exposure means is reflected on the front face and front face of the tabular transparent body. A board thickness detection means measures the time difference of each exposure light reflected on the front face and front face of the tabular transparent body, and asks for the board thickness of the tabular transparent body based on the measured time difference. An angle-of-reflection detection means detects the optical-path location of the reflected light to coincidence, and asks it for the angle of reflection of the reflected light based on the detected optical-path location. An operation means asks for the tilt angle or curvature of the tabular transparent body based on the angle of reflection detected with the angle-of-reflection detection means, and amends the board thickness of the called-for tabular transparent body.
[0010]
[Example] It explains in detail about the board thickness measuring method and equipment of the tabular transparent body to start this invention according to an accompanying drawing below. It is the perspective view of the board thickness measuring device of the tabular transparent body that drawing 1 starts this invention, and drawing 2 is the explanatory view of operation. The board thickness measuring device 30 of the tabular transparent body is equipped with board thickness measurement means 32A of the right-hand side used as bilateral symmetry, and left-hand side board thickness measurement means 32B, and each board thickness measurement means 32A and 32B is contained in the sensor box 33. And the board thickness measurement means 32A and 32B are sharing the polygon mirror 34, respectively.
[0011] The polygon mirror 34 is supported free [rotation] in the center of abbreviation of the sensor box 33, and is rotated with a fixed rotational speed in the direction of an arrow head (the direction of a clockwise rotation). Right-hand side board thickness measurement means 32A was equipped with laser light source (exposure means) 36A, board thickness detection sensor (board thickness detection means) 38A, location detection sensor (angle-of-reflection detection means) 40A, operation means 41A (refer to drawing 2), etc., and left-hand side board thickness measurement means 32B is equipped with laser light source 36B, board thickness detection sensor 38B, location detection sensor 40B, an operation means (not shown), etc. In addition, since right-hand side board thickness measurement means 32A and left-hand side board thickness measurement means 32B are constituted by bilateral symmetry, hereafter, they explain right-hand side board thickness measurement means 32A, and omit explanation about left-hand side board thickness measurement means 32B.
[0012] Laser light source 36of right-hand side board thickness measurement means 32A A is prepared in the upper right direction of the polygon mirror 34, and laser light source 36A is floodlighted ahead (left) by making the spot-like laser beam (exposure light) 42 into parallel light. Prism 44A is prepared ahead of laser light source 36A (left-hand side), and prism 44A reflects

downward the laser beam 42 floodlighted from laser light source 36A at the include angle of 90 degrees of abbreviation, and leads it to the right-hand side peripheral surface of the polygon mirror 34. Rightward [of the polygon mirror 34] condenser lens 46A is arranged, and, rightward [of condenser lens 46A], half mirror 48A is arranged. Moreover, rightward [of half mirror 48A], prism 50A is arranged.

[0013] And condenser lens 46A leads the laser beam 42 scanned by the polygon mirror 34 as an parallel light to half mirror 48A, and half mirror 48A penetrates one half of the laser beams 42 transmitted from condenser lens 46A, and leads it to prism 50A. Prism 50A reflects the laser beam 42 transmitted from half mirror 48A in the direction of lower part slant, and carries out incidence of the reflected laser beam 42 to sheet glass 52 by the incident angle theta. Thereby, a laser beam 42 is reflected with the front face and rear face of sheet glass 52. Sheet glass 52 is located under the polygon mirror 34, and is conveyed in the direction of an arrow head.

[0014] Prism 50B and half mirror 48B are arranged in the left-hand side upper part of sheet glass 52, and prism 50B and half mirror 48B are located in the position of symmetry of prism 50A and half mirror 48A focusing on the polygon mirror 34. The laser beam 42 reflected in prism 50B with the front face and rear face of sheet glass 52 carries out incidence, and prism 50B reflects horizontally the laser beam 42 which carried out incidence, and draws it to half mirror 48B. Half mirror 48B reflects one half of laser beams 42 in a longitudinal direction 90 degrees of abbreviation.

[0015] Condenser lens 54A is arranged in the longitudinal direction of half mirror 48B, and prism 56A is arranged in the longitudinal direction of condenser lens 54A. And condenser lens 54A leads the laser beam 42 reflected by half mirror 48B to prism 56A, and prism 56A reflects horizontally 90 degrees of laser beams 42 transmitted from condenser lens 54A. Half mirror 58A is arranged in the travelling direction of a laser beam 42 reflected by prism 56A. Half mirror 58A penetrates one half of incident light, draws it rightward, reflects horizontally the 90 degrees remaining laser beam 42B, and leads it to a longitudinal direction.

[0016] Rightward [of half mirror 58A], board thickness detection sensor 38A is prepared. A photodiode is used as one example and, as for board thickness detection sensor 38A, slit 39A is prepared in the front face of board thickness detection sensor 38A. Therefore, laser beam 42A which penetrated half mirror 58A carries out incidence to board thickness detection sensor 38A through slit 39A. In this case, if the rotational speed of the polygon mirror 34 is set up uniformly and the scan speed v of a laser beam 42 is set up uniformly, the laser beam reflected on the front face of sheet glass 52 and the laser beam reflected with the rear face of sheet glass 52 will be detected with the time interval proportional to swath width D.

[0017] Therefore, the time difference to which the laser beam reflected on the front face of sheet glass 52 and the laser beam reflected with the rear face of sheet glass 52 reach board thickness detection sensor 38A through slit 39A is measured, and it asks for the temporary board thickness of sheet glass 52. The temporary board thickness called for by board thickness detection sensor 38A is inputted into operation means 41A mentioned later. Moreover, location detection sensor 40A is arranged in the longitudinal direction of half mirror 58A. 2-dimensional PSD (it is a location detection sensor with Position Sensing Device. Japanese) is used as one example, and laser beam 42B reflected by half mirror 58A carries out incidence of the location detection sensor 40A to location detection sensor 40A. Hereafter, location detection sensor 40A is explained in drawing 2 . When sheet glass 52 does not incline, a laser beam 42 is reflected by angle of reflection theta (refer to drawing 1). On the other hand, glass 52 is delta 1 as shown in drawing 2 . When it inclines, the angle of reflection of a laser beam 42 is theta 1 from angle of reflection theta. It shifts caudad. Moreover, glass 52delta2 When it inclines, the angle of reflection of a laser beam 42 is theta 2 from angle of reflection theta. It shifts up.

[0018] Here, angle of reflection is theta 1 from angle of reflection theta. The case where it shifts caudad is explained. When laser beam 42A carries out incidence to board thickness detection sensor 38A, location detection sensor 40A detects the optical-path location of laser beam 42B which carried out incidence to location detection sensor 40A. And it is based on the optical-path location which the working distance L (distance between the base of the sensor box 33 and the conveyance side of sheet glass 52) and location detection sensor 40A detected, and is the angle-of-reflection gap theta 1 of a laser beam 42. It computes. Moreover, the angle of reflection of laser beam 42A is theta 2 from

angle of reflection theta. When it shifts, it is computed similarly.

[0019] Board thickness detection sensor 38of board thickness measurement means 32B of left-hand side shown in drawing 1 B and location detection sensor 40B are used for coincidence, and sheet glass 52 is delta 1. Angle-of-reflection gap theta1 ' (refer to drawing 3) of the laser beam 42 at the time of inclining is computed. And operation means 41A is delta 1 of the angle-of-reflection gap theta 1 of a laser beam 42 and theta1 ' to sheet glass 52. A tilt angle is computed. Moreover, delta 2 of sheet glass 52 A tilt angle is computed similarly. And a part for an error is amended from the board thickness measurement error graph (refer to drawing 4) by the inclination of the sheet glass 52 measured beforehand.

[0020] As shown in drawing 3 , it can ask for a tilt angle when a (double beam method) and sheet glass 52 incline by making sheet glass 52 irradiate a laser beam 42 aslant from a longitudinal direction, respectively. On the other hand, when sheet glass 52 is made to irradiate a laser beam 42 aslant only from either of the longitudinal directions, a (single beam system) and sheet glass 52 cannot distinguish whether it is in the condition which carried out vertical migration of whether it is in an inclination condition in the vertical direction.

[0021] Next, a board thickness measurement error graph is explained in drawing 4 . A board thickness measurement error graph shows the relation between whenever [over the sheet glass 52 of a laser beam 42 / incident angle], and board thickness correction value, an axis of ordinate shows board thickness correction value, and the axis of abscissa shows whenever [tilt-angle / of sheet glass 52]. For example, it sets in a board thickness measurement error graph, and is the graph G1 of left riser inclination. It considers as the graph for which it asked from right-hand side board thickness measurement means 32A, and is the graph G2 of left riser inclination. When it is the graph for which it asked from right-hand side board thickness measurement means 32A, it is a graph G1 and G2. The correction value of the board thickness of the sheet glass 52 at the time of making sheet glass 52 incline in 0-**50 (minute) is calculated.

[0022] This board thickness measurement error graph is beforehand created before board thickness measurement of sheet glass 52. Therefore, it is the tilt angle delta 1 of sheet glass 52, and delta 2 with the approach mentioned above. When it asks, it is a board thickness measurement error graph to the graph G1, and G2. Board thickness correction value can be calculated. for example, tilt angle delta 1 of sheet glass 52 the case where it asks with +30 minutes -- a graph G1 and G2 from -- each board thickness correction value S1 and S2 asking -- the board thickness correction value S1 and S2 being based -- tilt angle delta 1 of sheet glass 52 A part for the board thickness error at the time is amended.

[0023] Although said example explained the case where a part for a board thickness error when sheet glass 52 inclines was amended, the board thickness measuring method and equipment of the tabular transparent body not only concerning this but this invention can be used for the amendment for a board thickness error of the board thickness measured value of the sheet glass with which the wave was formed. The case where the board thickness of the sheet glass 62 with which the wave was formed in drawing 5 is amended hereafter is explained. Drawing 5 is the top view having shown the condition that the laser beam 42 floodlighted from laser light source 36A and laser light source 36B was reflected with sheet glass 62 through prism 50A and prism 50B (refer to drawing 1), respectively.

[0024] In this case, board thickness detection sensor 38A asks for the temporary board thickness of the curved-surface-like sheet glass 62 by the wave like said example. That is, board thickness detection sensor 38A measures the time difference to which the laser beam reflected on the front face of curved-surface-like sheet glass 62 and the laser beam reflected with the rear face reach board thickness detection sensor 38A through slit 39A, and asks for the board thickness of curved-surface-like sheet glass 62. Furthermore, location detection sensor 40B asks for each angle-of-reflection gap theta 3 of laser beams 42 and 42 and theta3 ' like said example, and operation means 41A asks for the curvature of curved-surface-like sheet glass 62 from the angle-of-reflection gap theta 3 of a laser beam 42 and theta3 '. And operation means 41A amends the measurement error of the temporary board thickness of curved-surface-like sheet glass 62 in quest of the correction value corresponding to the curvature of curved-surface-like sheet glass 62.

[0025]

[Effect of the Invention] According to the board thickness measuring method and equipment of the tabular transparent body which are applied to this invention as explained above, a board thickness detection means measures the time difference of each exposure light reflected on the front face and front face of the tabular transparent body, and asks for the board thickness of the tabular transparent body based on the measured time difference. An angle-of-reflection detection means detects the optical-path location of the reflected light to coincidence, and asks it for the angle of reflection of the reflected light based on the detected optical-path location. An operation means asks for the tilt angle or curvature of the tabular transparent body based on the angle of reflection detected with the angle-of-reflection detection means, and amends the board thickness of the called-for tabular transparent body.
[0026] Therefore, when the tabular transparent body inclined by vibration, or even when the wave is formed in the tabular transparent body, the board thickness of the tabular transparent body can be computed correctly.

[Translation done.]

EXAMPLE

[Example] It explains in detail about the board thickness measuring method and equipment of the tabular transparent body to start this invention according to an accompanying drawing below. It is the perspective view of the board thickness measuring device of the tabular transparent body that drawing 1 starts this invention, and drawing 2 is the explanatory view of operation. The board thickness measuring device 30 of the tabular transparent body is equipped with board thickness measurement means 32A of the right-hand side used as bilateral symmetry, and left-hand side board thickness measurement means 32B, and each board thickness measurement means 32A and 32B is contained in the sensor box 33. And the board thickness measurement means 32A and 32B are sharing the polygon mirror 34, respectively.
[0011] The polygon mirror 34 is supported free [rotation] in the center of abbreviation of the sensor box 33, and is rotated with a fixed rotational speed in the direction of an arrow head (the direction of a clockwise rotation). Right-hand side board thickness measurement means 32A is a laser light source.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The perspective view showing the whole board thickness measuring device of the tabular transparent body concerning this invention
[Drawing 2] The explanatory view explaining actuation of the board thickness measuring device of the tabular transparent body concerning this invention
[Drawing 3] The explanatory view explaining the reflective condition of a laser beam when sheet glass inclines
[Drawing 4] The board thickness measurement error graph which showed the relation between whenever [incident angle / of a laser beam], and board thickness correction value
[Drawing 5] The explanatory view explaining the reflective condition of the laser beam in curved-surface-like sheet glass
[Drawing 6] The front view showing the board thickness measuring device of the conventional tabular transparent body
[Description of Notations]
30 -- Board thickness measuring device of the tabular transparent body
42 -- Laser beam (exposure light)
52 62 -- Sheet glass (tabular transparent body)
36A, 36B -- Laser light source (exposure means)
38A, 38B -- Board thickness detection sensor (board thickness detection means)
40A, 40B -- Location detection sensor (angle-of-reflection detection means)
41A -- Operation means

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Irradiate so that incidence of the exposure light may be aslant carried out on the front face of the tabular transparent body, and parallel scanning of this exposure light is carried out. The time difference of the reflected light reflected on the front face of said tabular transparent body of said exposure light and the reflected light reflected with the rear face of said tabular transparent body of said exposure light is measured. Ask for the board thickness of said tabular transparent body based on the measured this time difference, and the angle of reflection of said reflected light reflected with the front face and rear face of said tabular transparent body is searched for. The board thickness measuring method of the tabular transparent body characterized by asking for the tilt angle of said tabular transparent body based on the angle of reflection of said reflected light, and amending said called-for board thickness based on the tilt angle of said said tabular transparent body.
[Claim 2] Irradiate so that incidence of the exposure light may be aslant carried out on the front face of the tabular transparent body, and parallel scanning of this exposure light is carried out. The time difference of the reflected light reflected on the front face of said tabular transparent body of said exposure light and the reflected light reflected with the rear face of said tabular transparent body of said exposure light is measured. Ask for the board thickness of said tabular transparent body based on the measured this time difference, and the angle of reflection of said reflected light reflected with the front face and rear face of said tabular transparent body is searched for. The board thickness measuring method of the tabular transparent body characterized by asking for the curvature of said tabular transparent body based on the angle of reflection of said reflected light, and amending said called-for board thickness based on the curvature of said said tabular transparent body.
[Claim 3] An exposure means to irradiate so that incidence of the exposure light may be aslant carried out on the front face of the tabular transparent body, A board thickness detection means to measure the time difference of the reflected light reflected on the front face of said tabular transparent body of said exposure light, and the reflected light reflected with the rear face of said tabular transparent body of said exposure light, and to ask for the board thickness of said tabular transparent body based on the this measured time difference, An angle-of-reflection detection means to detect the angle of reflection of said reflected light reflected with the front face and rear face of said tabular transparent body, The board thickness measuring device of the tabular transparent body characterized by having an operation means to ask for the tilt angle of said tabular transparent body based on the angle of reflection of said reflected light, and to amend said called-for board thickness based on the tilt angle of this tabular transparent body.
[Claim 4] An exposure means to irradiate so that incidence of the exposure light may be aslant carried out on the front face of the tabular transparent body, A board thickness detection means to measure the time difference of the reflected light reflected on the front face of said tabular transparent body of said exposure light, and the reflected light reflected with the rear face of said tabular transparent body of said exposure light, and to ask for the board thickness of said tabular transparent body based on the this measured time difference, An angle-of-reflection detection means to detect the angle of reflection of said reflected light reflected with the front face and rear face of said tabular transparent body, The board thickness measuring device of the tabular transparent body characterized by having an operation means to ask for the curvature of said tabular transparent body based on the angle of reflection of said reflected light, and to amend said called-for board thickness

based on the curvature of this tabular transparent body.

[Translation done.]